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G4A

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(54) Computer memories

(57) In order to extend a random access memory (RAM) 18 within a computer, additional RAM 34 is provided which may be in the form of a plug-in component. The component includes signal paths which allow communication between the computer processor 32 and either the existing RAM 18 or the additional RAM 34. Routing of information is carried out in response to data indicative of information to be displayed to establish the signal paths between the processor and the existing and the additional RAM so that screen information is always routed to or from the existing RAM, the additional RAM and any spare existing RAM being used for program and data storage.

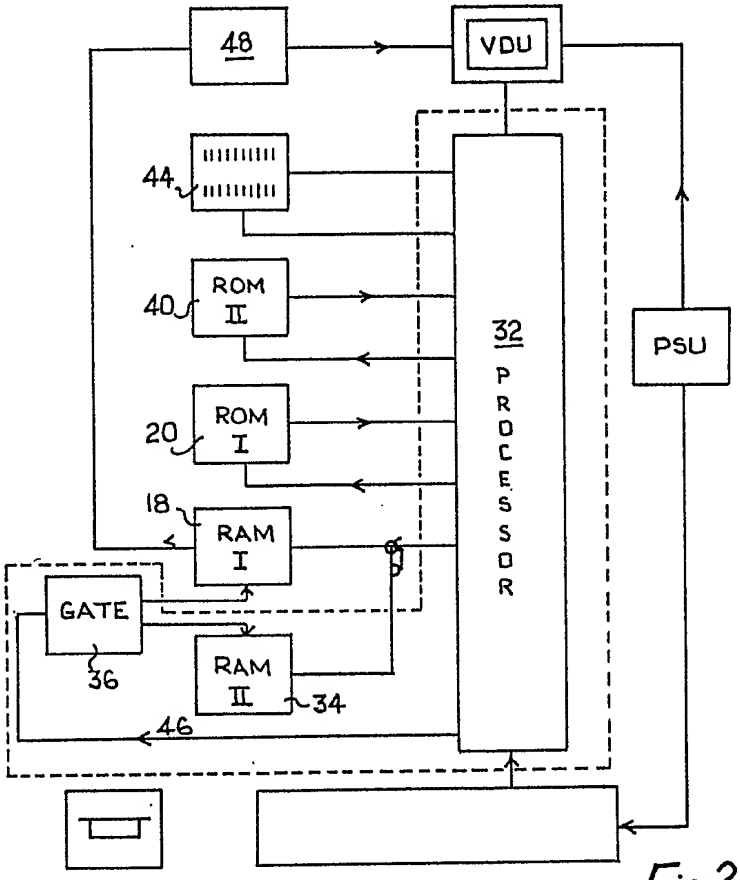

Fig.2

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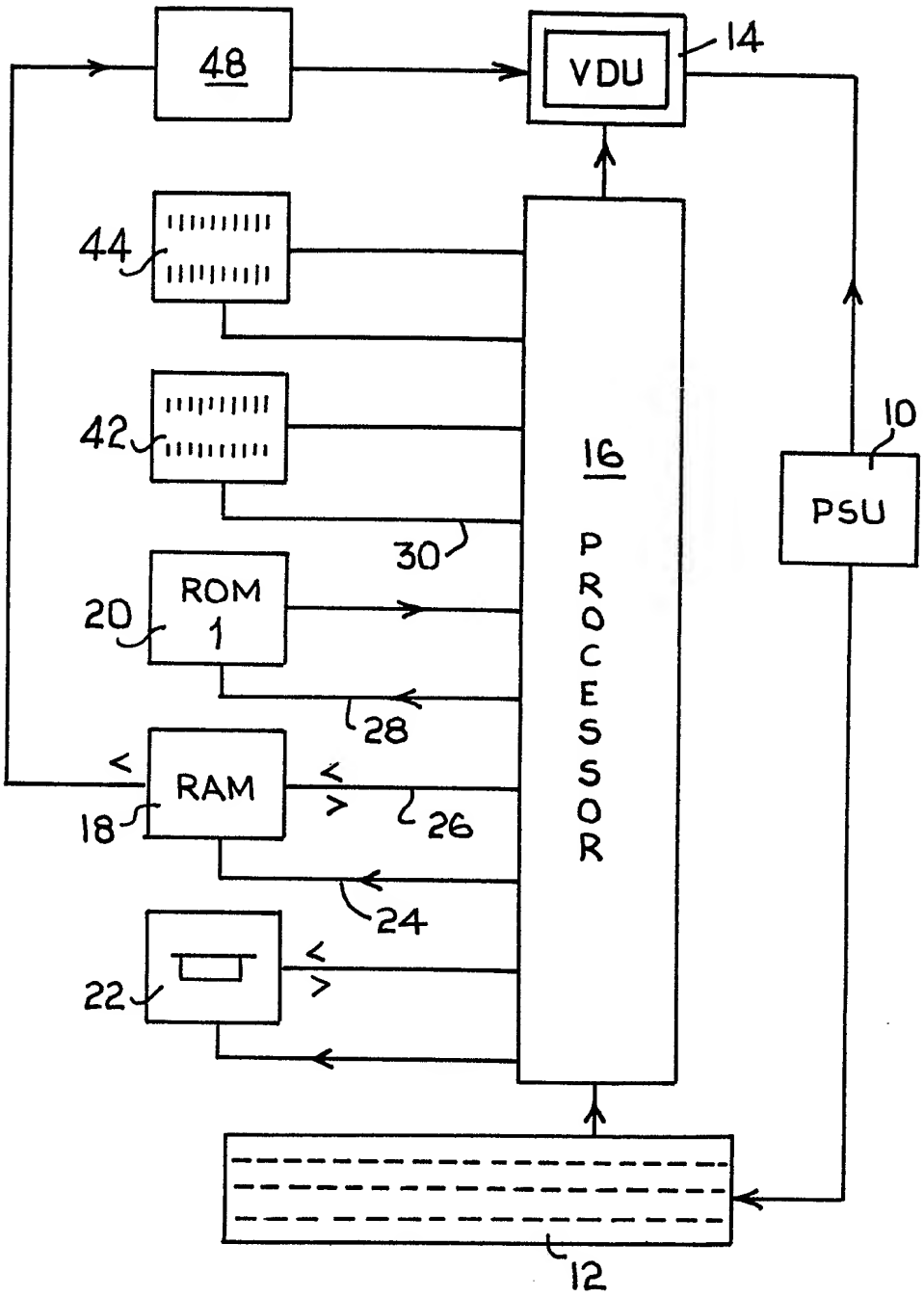

Fig. 1

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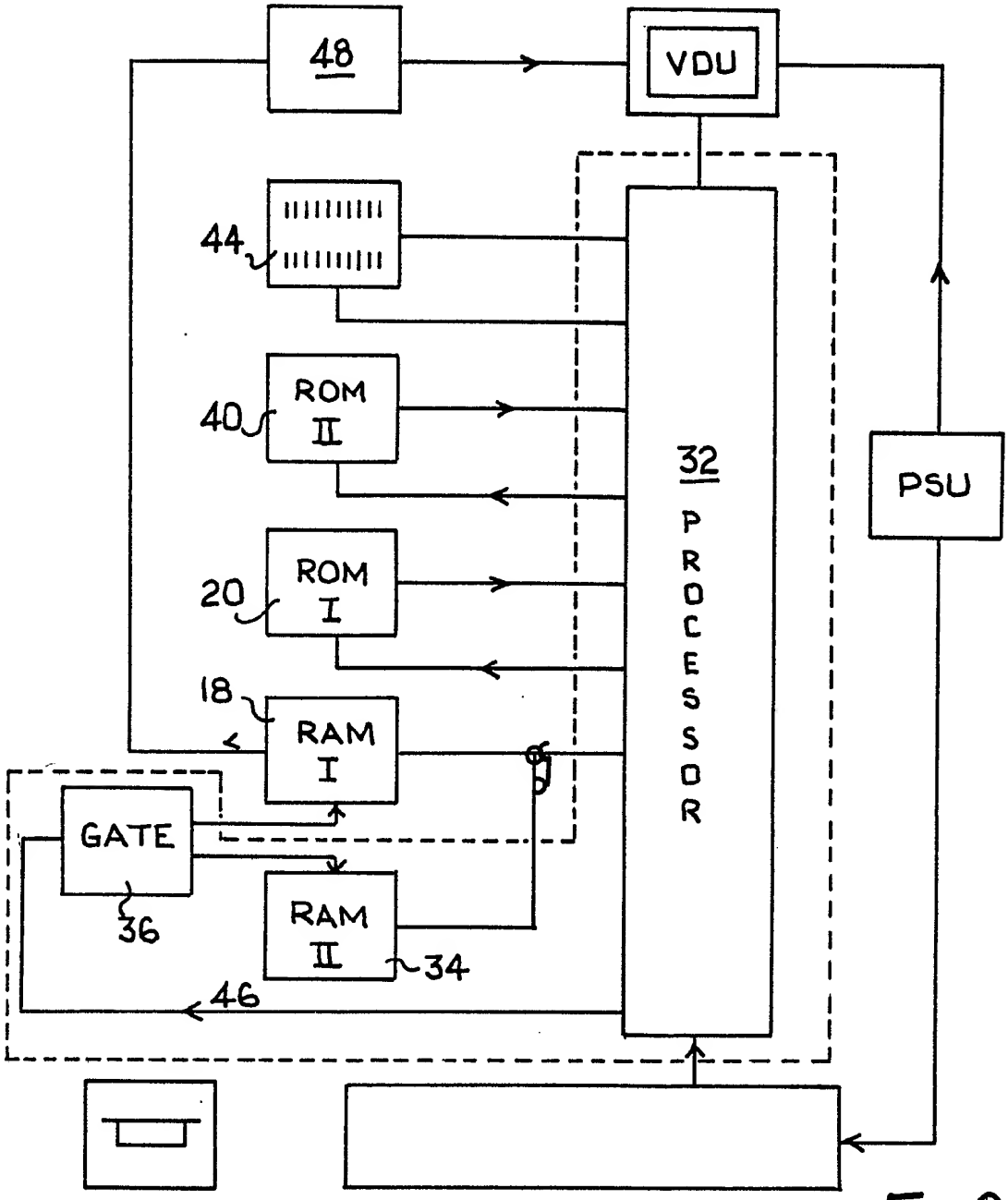

Fig.2

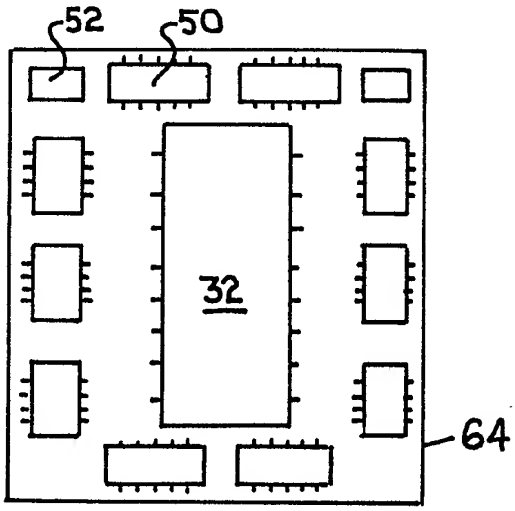

Fig.3

SPECIFICATION

Improvements in and relating to computer memories

Field of invention

This invention concerns computer memories and in particular to a system by which random access memory within a computer may be extended to provide an increased capacity of random access memory to the processor within the computer.

Background of the invention

In many computers which contain inter alia a processor and random access memory (RAM), at least part of the resident RAM is accessible by both display circuitry and the processor so that program information and/or data information and/or screen information (ie information to be displayed on the television screen linked to the computer) can be stored therein. In such computers it is usual to provide a facility by which that part of the resident RAM from which information will be displayed on the screen can be identified (the remainder of the resident RAM therefore being available for any other information to be stored). However it will be seen that if a large section of the resident RAM is identified as being reserved for information to be displayed on the screen, there will in consequence be less resident RAM available for storage of other information such as program information and data information.

Thus with a fixed amount of resident RAM, there is in practice a limit on the amount of screen information which can be stored in the resident RAM and this limit decreases with increasing size of program and/or quantity of data information which has to be stored.

It is an object of the present invention to provide a system by which the capacity of the RAM resident in a computer can be increased without significant rewiring of the basic computer so as to enable the user or owner of such a computer to acquire the essential pieces of hardware and to insert this hardware into the existing computer circuitry with minimum interference so as to thereby increase the random access memory (RAM) available to the processor.

Summary of the invention

According to the present invention in a computer containing a processor and resident RAM at least part of which is accessible by both display circuitry and the processor so that program information and/or data information and/or screen information can be stored therein so that in practice there is a limit on the amount of screen information which can be stored in the resident RAM (which limit decreases with increasing size of program and/or quantity of data information to be stored) and which further includes means for identifying that part of the resident RAM from which information will be displayed on the screen (the remainder of the resident RAM being available for any other information to be stored); the improvement comprising:

1. additional RAM means;

2. signal path means by which information can pass between the processor and either the resident RAM or the additional RAM; and

3. routing means responsive to data indicative of information to be displayed to establish signal paths between the processor and either the resident RAM or the additional RAM, whereby screen information is always routed to and from the said identified part of the resident RAM whilst program information and a data information are routed elsewhere.

Where the processor is plug-in device the additional RAM, the routing means and the signal path means are preferably contained on a mounting which is designed to plug into the processor socket in place of the processor normally located therein and the mounting itself either contains a socket into which the processor (or another processor) can be fitted or contains another processor permanently mounted therein or thereon.

By allowing for the insertion of an alternative processor so the power requirements can be kept within the limits of the existing power supply by selecting a processor which in conjunction with the other devices contained on the said mounting, makes no greater demand on the existing computer power supply than the original processor.

Preferably the routing is controlled by control signals derived from a Read Only Memory (ROM).

Where the computer includes plug-in sockets adapted to receive read only memories (ROM's) containing data or program information or both, control signals for controlling the routing are conveniently stored in a read only memory which is adpated to be plugged into such plug-in socket.

Additionally where the processor is a plug-in device, the additional random access memory (RAM) routing means and signal path means may be contained in a single device which is adpated to be plugged into the processor socket in place of the original processor and may for example to be an integrated circuit which may or may not be encapsulated.

It will be seen that the invention thus allows an existing computer having an existing level of resident random access memory to be extended so as to provide for the processor (or another processor) additional random access memory thereby increasing the available random access memory beyond the limit previously available to the processor.

The invention is of particular advantage in an arrangement in which the additonal random access memory and associated circuitry and devices together with either the original processor or an alternative processor can be contained on a single board which itself can be mounted in place of the original processor within the computer typically by removing the original processor and plugging the unit containing the additonal random access memory etc into the socket normally occupied by the original processor.

The invention is particularly but not exclusively applicable to a micro computer such as that manufactured and sold by the Acorn Computer Company Limited of Cambridge, England and supplied as the

so called BBC Computer where the micro processor incorporated into the computer is a conventional plug-in integrated circuit and removal of the processor from the main computer board allows a supplementary printed circuit board having an appropriate socket mounted on its underside, to be plugged into the processor socket in place of the original processor. The original processor can then be plugged into an appropriate socket provided on the supplementary board or an alternative processor may be plugged therein to, typically a processor having at least the same capabilities as the original processor but having less demanding power requirements so that the overall power requirement of the supplementary board is no greater than the power requirement for the original processor.

It is of course not essential for the supplementary board in such a system to have a socket into which the original processor or another processor can be fitted but instead one or more processors may be permanently mounted on the board together with the other components associated with the additional random access memory and routing circuits etc so that no action is required by the user/operator other than to remove the computer cover and main processor from the processor socket, and insert into the latter the plug assembly on the underside of the supplementary board containing all the components (including a replacement for the original processor).

The invention also lies in a method of extending the random access memory available within a computer containing a processor and resident random access memory at least part of which is accessible by both display circuitry and the processor so that program information and/or data information and/or screen information can be stored therein and which includes means for identifying that part of the resident RAM from which information will be displayed on the screen (the remainder of the resident RAM being available for any other information to be stored therein); comprising the steps of:

1. removing the said processor,

2. replacing the processor by a subsidiary unit containing processor means, signal path means and additional random access memory connected to the processor means by the signal path means and routing means which is adapted to be responsive to data indicative of information to be displayed by the computer, to establish signal paths between the processor and either the resident RAM or the additional RAM to enable screen information always to be routed to and from the said identified part of the resident RAM whilst allowing program information and data information to be routed to the remainder of the resident and additional RAM's.

The said processor means mounted on the additional unit may be detachable therefrom and may be the original processor removed from the original socket or may be an alternative processor.

According to another aspect of the present invention apparatus for modifying a computer so as to extend the random access memory avaiable to a processor normally contained within the computer, in which the said processor normally contained therein is a so called plug-in component and can be removed from a socket into which it is normally plugged, comprises:

1. a component assembly or integrated circuit having a plug member adapted to fit into the said processor socket,

2. additional random access memory contained on the component assembly or within the said integrated circuit,

3. signal path means connecting the said additional random access memory to a processor mounted on the sub-assembly, and

4. routing means for establishing single paths between the processor and either the resident RAM or the additional RAM, the routing means being responsive to data indicative information to be displayed by the computer, whereby screen information is always routed to and from that part of the resident random access memory which is identified as being for storage of screen information and program information and data information are routed to the remainder of the said resident and additional RAM.

The invention is of particular application where the random access memory available to a computer processor has to serve as the storage device for information which is to be displayed and additionally for information relating to program and/or data. Thus in a computer having 32K of resident RAM a significant advantage can be obtained by providing an additional 20K of random access memory in the manner provided by the invention so as to provide in all 52K of random access memory within the computer (32K of resident RAM and 20K of additional RAM).

The routing of information to be stored in the random access memory so as to ensure that screen information is always stored in the apropriate part of the random access memory (accessible by both screen circuitry and processor) is most simply achieved by introducing into the program, instructions to establish an appropriate signal path to the resident random access memory or the remainder of the random access memory (either resident or additonal) depending on whether the information to be stored is screen information (ie information which will result in a display on the screen) or not.

The control of the routing is most simply achieved by introducing into the computer programme a response to the calling up of those parts of the operating system which relate to character generation on the screen and to the return from the operating system to the main program.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a simplified circuit diagram of a microcomputer

Figure 2 is a simplified circuit diagram of the micro computer of Figure 1 modified in accordance to the invention and

Figure 3 illustrates how some of the components making up the modified computer of Figure 2 can be mounted.

Detailed description of drawings

In Figure 1 a microcomputer is shown as being made up of a power supply unit 10 feeding a keyboard unit 12 a visual display unit 14 and a micro processor 16. The latter is shown connected to a random access memory (RAM) 18, a read only memory (ROM) 20 and to a disc or a tape store 22. In each case only the circuit paths essential for an understanding of the invention are shown.

The processor can address the random access memory by sending signals along path 24 and data for storing in the memory or read from locations within the memory passes along signal path 26.

In the same way the ROM 20 is addressed by signals along signal path 28 and information from the memory is supplied to the processor along line 30.

In practice the ROM 20 will include inter alia the operating system and other essential data and will normally include information by which information stored in the RAM 18 or in a disc or on cassette in dirve 22 can be displayed as recognizable characters on the screen of the visual display unit (VDU) 14.

The RAM 18 will be referred to as the resident RAM, ie the random access memory built into the computer by the original manufacturer. It is assumed that for the purposes of the invention that where RAM extension facilities are available within the computer, these have all been taken up and RAM 18 is therefore considered to be the total random access memory capability of the computer as provided by the manufacturer.

The processor 16 is assumed to be a plug-in component or at least a component that can be removed to allow an alternative component to be connected in its place, albeit a component or sub-assembly containing components which is more than the original processor.

Figure 2 shows the configuration of the computer of Figure 1 when modified by the present invention. Here the original processor 16 is replaced by a circuit board containing a processor 32, additional random access memory 34 and signal paths and routing means designated by a gate 36. These components are all shown within dotted outline 38.

By appropriate selection of replacement processor 32 so the additional power requirements for the additional RAM 34 and rooting device or devices can be made not greater (and in some cases less than) the power requirements of the original processor 16.

Where the power supply capabilities are appropriate, the original processor 16 may of course be employed together with the additional random access memory 34 and routing device 36.

In addition to the replacement for the processor 16, a second read only memory (ROM) 40 is shown. The latter is fitted into one of the spare ROM sockets designated at 42 and 44 in Figure 1 and normally provided in mircocomputers to allow for additional operating systems to be provided and additional programs to be plugged into the equipment.

In accordance with the invention, the gate 36 is controlled by signals from the processor along the line 46 so as to cause RAM 18 or RAM 34 to be selected and the sub-routines required over and above the normal operating system contained in ROM 20 are contained in the additional ROM 40 so that when the main program calls for the storage of screen information the latter is directed to RAM 18 whereas data information and program information can be directed to either RAM 18 (assuming there is supplus RAM available therein) or to RAM 34.

Referring back to Figure 1, it will be seen that RAM 18 is accessible both to the processor 16 and to the screen circuitry 48 whereas by comparison, in Figure 2, RAM 2 is only accessible to the processor.

The net result is that by providing sufficient additional RAM in RAM 34 so the full screen capabilty (as dictated by the maximum area of RAM 18 which can be identified for the storage of screen information) can be utilised without any reduction in the random access memory availability for the storage of data and program information.

It should be noted that the additional random access memory is only availabe for the storage of data information and program information since only RAM 18 is accessible to both processor and screen circuitry,

Figure 3 illustrates how the alternative processor 32 (which may in certain circumstances be the original processor 16, simply re-used) together with devices which together make up the additional random access memory 34 one of which is identified by reference numeral 50 together with such other devices as are required to establish the routing and signal path function of gate 36 (one of which is illustrated at 52) can be mounted on a single printed circuit board 54 the underside of which includes a plurality of conductive pins arranged in the same pattern and spacing as the pins of the processor 16 so that the circuit board 54 can be plugged into the socket (not shown) normally occupied by the processor 16 of the original computer.

As shown in Figure 3 there are 10 integrated circuits of which one is exemplified by reference numeral 50 and typically each of these is in the form of a 2K random access memory so that the total of all 10 devices is 20K of random access memory.

The additional processor 32 may be the original processor 16 simply re-located into an appropriate socket (not shown) secured to the upper side of the printed circuit board 54 but is more preferably an alternative processor having a lowered current requirement than the processor 16 so that the overall current requirement of the board 54 is no greater than the power requirement of the original processor 16.

Although a second ROM 40 has been illustrated as being required, it is of course feasible for an alternative ROM 20 to be provided in place of the original ROM 20 so that the aditonal ROM sockets 42 and 44 are not occupied by the further ROM required to provide the additional operating system functions to allow for routing between the two random access memories 18 and 34. However, where the ROM 20 is permanently connected to the computer board it may be more preferable to provide an additional ROM such as 40 as shown in Figure 2 and to sacrifice one of the spare ROM positions so as to obviate the need for the owner or user of the equipment to have to replace a hard wired component with another

hard wired component.

In the alternative, ROM 40 need not be dedicated to solely the additional sub-routines required to modify the operating systems for the processor 32 but may include additional data or programmes or sub-routines or the like in addition to the information needed to enhance the ordinary operating system to allow for the routing between the random access memories 18 and 34.

Where it can be accommodated, the ROM 40 or an equivalent thereof may be located on the additional circuit board 54 and appropriate connections made to the alternative processor 32 mounted on the circuit board 54.

Although the invention has been described in relation to Figure 3 in the form of discreet components mounted on a printed circuit board it is to be understood that the invention is not limited to this configuration and alternatively all of the devices making up the additional random access memory, the alternative processor, the routing and control circuits and signal paths can be combined into a single integrated circuit which can simply be plugged into the socket (not shown) for the processor 16, in place of the latter.

CLAIMS

1. A computer containing a processor and resident RAM, at least part of the resident RAM being accessible by both display circuitry and the processor so that program information and/or data information and/or screen information can be stored therein, and means for identifying that part of the resident RAM from which information will be displayed on the screen (the remainder of the resident RAM being available for any other information to be stored); the improvement comprising:

a) additional RAM means;

b) signal path means by which information can pass between the processor and either the resident RAM or the additional RAM; and

c) routing means responsive to data indicative of information to be displayed to establish signal paths between the processor and either the resident RAM or the additional RAM, whereby screen information is always routed to and from the said identified part of the resident RAM whilst proram information and data information are routed elsewhere.

2. A computer as claimed in claim 1, wherein the processor is a plug-in device, and the additional RAM, the routing means and the signal path means are contained on a mounting which is designed to plug into the processor socket in place of the processor normally located therein and the mounting itself either contains a socket into which the processor (or another processor) can be fitted or contains another processor permanently mounted therein or thereon.

3. A computer as claimed in claim 2, wherein the mounting is a single device in the form of an integrated circuit.

4. A computer as claimed in claim 3, wherein the integrated circuit is encapsulated.

5. A computer as claimed in any preceding claim wherein the routing is controlled by control signals derived from a Read Only Memory (ROM).

6. A computer as claimed in any preceding claim, wherein the computer includes plug-in sockets adapted to receive read only memories (ROM'S) containing data or program information or both, and control signals for controlling the routing are stored in a read only memory which is adapted to be plugged into such plug-in socket.

7. A computer as claimed in any preceding claim, wherein the additional random access memory and associated circuitry and devices together with either the original processor or an alternative processor are contained on a single board which itself can be mounted in place of the original processor within the computer.

8. A method of extending the random access memory available within a computer containing a processor and resident random access memory at least part of which is accessible by both display circuitry and the processor so that program information and/or data information and/or screen information can be stored therein and which includes means for identifying that part of the resident RAM from which infomation will be displayed on the screen (the remainder of the resident RAM being available for any other information to be stored therein); comprising the steps of:

a) removing the said processor,

b) replacing the processor by a subsidiary unit containing processor means, signal path means and additional random access memory connected to the processor means by the signal path means and routing means which is adapted to be responsive to data indicative of information to be displayed by the computer, to establish signal paths between the processor and either the resident RAM or the additional RAM to enable screen information always to be routed to and from the said identified part of the resident RAM whilst allowing program information and data information to be routed to the remainer of the resident and additional RAM'S.

9. A method as claimed in claim 8, wherein the said processor means mounted on the additional unit are detachable therefrom and may be the original processor removed from the original socket or may be an alternative processor.

10. Apparatus for modifying a computer so as to extend the random access memory available to a processor normally contained within the computer, in which the said processor normally contained therein is a so called plug-in component and can be removed from a socket into which it is normally plugged, the apparatus comprising:

a) a component assembly or integrated circuit having a plug member adapted to fit into the said processor socket,

b) additional random access memory contained on the component assembly or within the said integrated circuit,

c) a signal path means connecting the said additional random access memory to a processor mounted on the sub-assembly, and

d) routing means for establishing signal paths between the processor and either the resident RAM

or the additional RAM, the routing means being responsive to data indicative information to be displayed by the computer, whereby screen information is always routed to and from that part of the resident random access memory which is identified as being for storage of screen information and program information and data information are routed to the remainder of the said resident and additional RAM.

11. A computer substantially as herein described with reference to Figure 2 of the accompanying drawings.

12. Apparatus for modifying a computer, substantially as herein described with reference to Figure 3 of the accompanying drawings.

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